Lake Okeechobee Aquifer Storage and Recovery. DRAFT (9/11/98)

Description of Simulations

The objectives of this analysis are two-fold. The first objective is to estimate the portion of the benefits realized in Restudy 'Alternative D13R' (Restudy Hydrologic Performance Measure Web Page, June 19, 1998) that are associated with the Lake Okeechobee Aquifer Storage and Recovery (ASR) system; while the second objective is to estimate the sensitivity of regional hydrologic system performance to the assumed recovery efficiency of this ASR system.

The proposed Lake Okeechobee ASR system in this Alternative D13R is composed of a wellfield with two hundred wells that each have a pumpage capacity of 5 million gallons a day (MGD) for a total pumpage capacity of 1000 MGD. This pumpage capacity is assumed to be reversible so that maximum flow to or from the ASR system are the same. The reusable recovery efficiency is assumed to be seventy percent in Alternative D13R. In the South Florida Water Management Model (SFWMM; South Florida Water Management District, 1998), the efficiency of the ASR is accounted for upon injection to the aquifer so that the computed size of the freshwater aquifer storage (freshwater bubble) actually represents the available storage for reuse. In the sensitivity analysis, the recovery efficiency is reduced by one-half to thirty-five percent. Key performance measures are compared for the 2050 Base Case, Alternative D13R, Alternative D13R without Lake Okeechobee ASR, and Alternative D13R with reduced Lake Okeechobee ASR recovery efficiency.

Assumptions

Two SFWMM simulation runs were made:

1. Alternative D13R with the removal of Lake Okeechobee ASR,
2. Alternative D13R with Lake Okeechobee ASR recovery efficiency reduced from 70 percent assumed in Alternative D13R to 35 percent in this model simulation.

Summary of Results

Performance measures (PM) graphics comparing selected model outputs are attached (Figures 1-7). The 2050 Base Case, Alternative D13R (ALTD13R), ALTD13R with no Lake Okeechobee ASR (NOASR) and ALTD13R with Lake Okeechobee ASR recovery efficiency reduced by one-half (REDEFF) are sequentially displayed on each plot. The major findings of this analysis are:

- **Lake Okeechobee ASR Injection Volumes**

  The average annual injection volume for ALTD13R with a reduced ASR recovery efficiency was decreased from 263.6 thousand acre-feet (kaf) for the original ALTD13R simulation to 246.9 kaf for the reduced efficiency Lake ASR. This is a decrease of about 6 percent. This slight decrease is due to the lower water levels in the Lake Okeechobee meaning less water available for injection. The logic of the model does not alter the injection of Lake water into the ASR as a function of ASR efficiency. The dry season to wet season injected volumes were split 55%/45% for both ALTD13R and REDEFF.

- **Lake Okeechobee and Lower East Coast Water Supply**

  Lake Okeechobee service sub-areas experienced average annual shortages of about 25 percent in the 2050 Base. Alternative D13R reduced these shortages to about 6 percent. Removing the Lake Okeechobee ASR increases the shortages to about 11 percent. When the recovery efficiency of the ASR is cut in half, the percentage of demands not met only decreases slightly from the case of no ASR (Figure 1). During drought years the water shortages reduce from 33 percent in the 2050 Base to 13 percent with Alternative D13R. Removing the Lake ASR only slightly increases the volume of water use demands not met for the selected drought years. This is because the Lake ASR storage is depleted during the drought years. The low efficiency ASR results in slightly worse performance than the no ASR scenario during drought years.

  The marginal performance of the lower efficiency ASR in both Figure 1 and Figure 2 may be explained by comparing the average annual volume recovered to that injected for the two Lake ASR simulations. For the low performance ASR the annual average recovery to injection ratio is (55.3/246.9) kaf or an actual recovery percentage is about 22%. (Note that the computed volume efficiency is less than the assumed efficiency because a large volume of ASR storage exist at the end of the simulation). The ratio for the higher efficiency ASR is (135.7/264.6) kaf or about 51%. From another perspective, the annual volume gained from the low efficiency ASR (55 kaf) is about one-third of that lost (172 kaf), while for the more efficient ASR the average volume gained (136 kaf) is almost twice that which is lost (79 kaf). Of course, the 2050 Base and the Alternative D13R with no ASR had no aquifer injection and recovery.

  The number of Lower East Coast Service Area water use cutbacks was substantially reduced with Alternate D13R. In general, the number of cutback months for ALTD13R are less than 20% of those of the 2050 Base except for LECSA3 which was about 25%of the 2050 Base. Removing the Lake ASR from the Alternate D13R reduced this overall benefit; however, the other components of this alternative still allowed significant decreases in cutback months; such that the number of cutback months were still less than one-third of the 2050 Base in all Lower East Coast Services Areas except LECSA3. The cutback months in LECSA3 were 47% of the 2050 Base. The reduced efficiency ASR is only slightly better than the no Lake ASR simulation for reducing the number of months of cutbacks within the Lower East Coast Service Area. Figure 3 summarizes the cutback months for each Lower East Service Area and for each model simulation. It should be pointed out that locally-triggered cutback months were nearly the same for the three Alternative D13R simulations except for a slight increase by one cutback in LECSA2 for the simulation without the Lake ASR.

- **St. Lucie and Caloosahatchee Estuaries**

  Alternative D13R successfully reduced the number of times the St. Lucie and Caloosahatchee estuary salinity criteria were not met due to high flows from the Lake from 29 to 2 months. This is due to the redistribution of Lake

regulatory discharges away from the estuaries and to other outlets as illustrated in Figure 4. Alternative D13R had only 6 months, where the St Lucie estuary salinity envelope criteria were violated due to high flows from the Lake. A similar pattern of results was simulated for the Caloosahatchee estuary. Without the Lake ASR, the number of Zone A discharges to the Caloosahatchee estuary more than tripled (31 to 95 days), and discharges to the St. Lucie estuary more than doubled (24 to 65 days). Finally, as would be expected, the lower efficiency ASR was just as effective as the high efficiency ASR in reducing the large, high impact discharges to the estuaries. These performance measures are summarized in Figure 5A and 5B for the St. Lucie and Caloosahatchee estuaries respectively. The number of days of high impact Zone A discharges was also the same or slightly less for the low efficiency ASR.

- **Lake Okeechobee Littoral Zone**

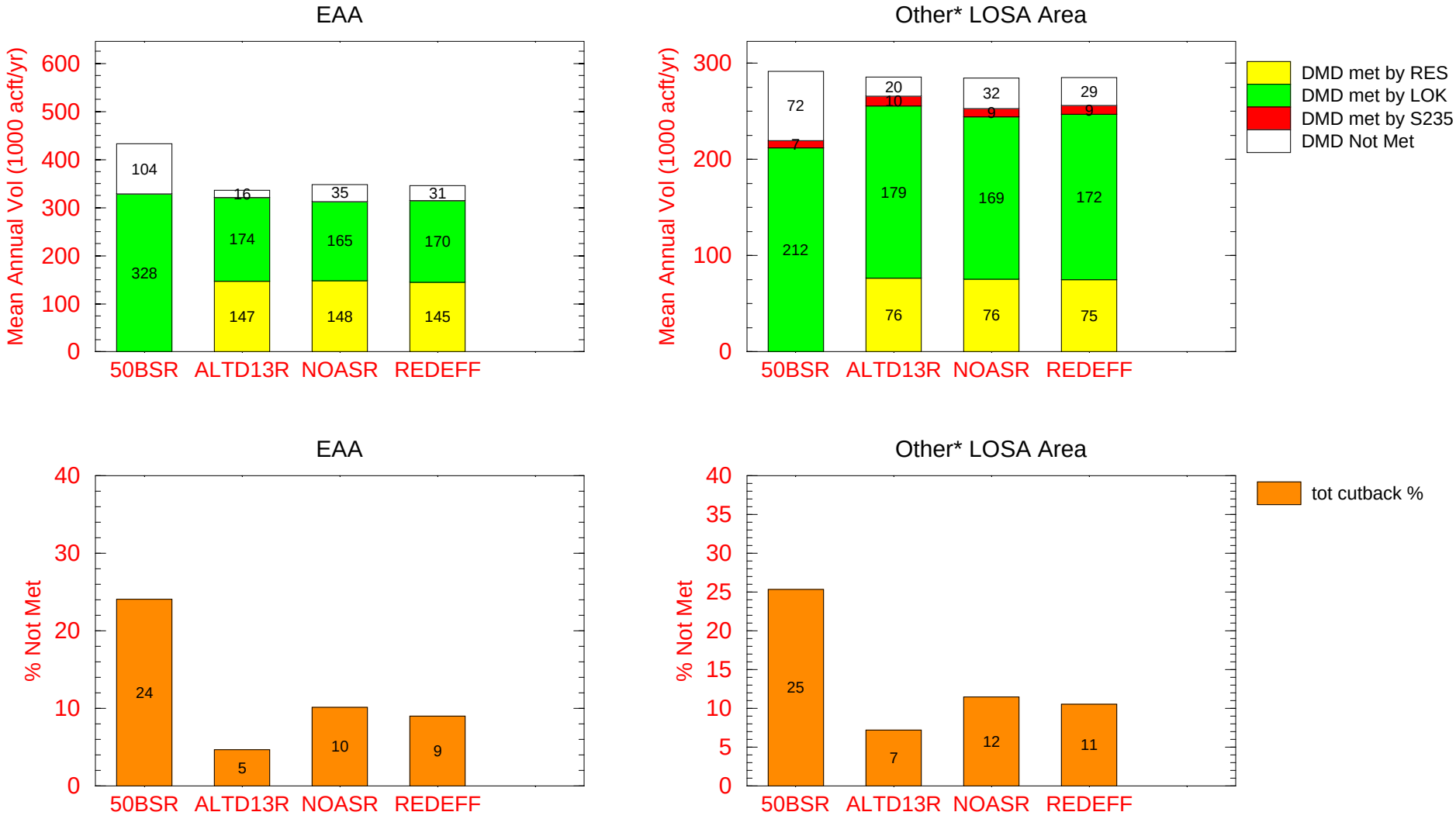
  Alternative D13R reduced the number of undesirable Lake water levels from 12 events in the 2050 Base simulation to 4 events in Alternative D13R. This Alternative was especially effective in reducing the large number of undesirable low water levels events (less than 11 feet NGVD) from 7 in the 2050 Base to 1 in Alternative D13R. When the ASR is removed from the Lake, the overall number of undesirable events increases from 4 to 9. However, only two of these events are associated with extended periods of Lake water levels below 11 feet. The lower efficiency ASR performs very similar to the higher efficiency ASR in terms of reducing the undesirable events for Lake Okeechobee ASR. It does contain one additional event associated with extended periods of Lake water levels below 11 feet. These results are summarized in Figure 6.

- **Everglades National Park**

  Alternative D13R significantly improves the spatial distribution of flows to the Everglades National Park compared to the 2050 Base. Removing the Lake ASR increases the magnitude slightly due to the increase in regulatory releases from the Lake to the Everglades. Figure 7 summarizes the changes in annual average flow across Tamiami Trail for each simulation considered. North East Shark River Slough (Indicator Region 11) had a significant reduction in the number (and duration) of undesirable, low water events with Alternative D13R. The 9 occurrences (average duration 6 weeks) of undesirable, low water level events associated with the 2050 Base condition is reduced to 3 events (average duration 2 weeks) with Alternative D13R. Removing the Lake ASR reduced the undesirable low water events by one from Alternative D13R. The average annual flows from the Lake to the Everglades were 161.6, 149.4, 144.6, and 151.2 kaf for the 2050 Base, Alternative D13R, the NOASR, and the REDEFF model simulations respectively. Flows from the EAA storage reservoirs were 0.0, 273.6, 245.4 and 263.4 kaf for the same set of model simulations.

Figure 1. Mean Annual EAA/LOSA Supplemental Irrigation: Demands and Demands Not Met

for the 1965 − 1995 Simulation Period



*Other Lake Service SubAreas (S236, S4, L8, C43, C44, and Seminole Indians (Brighton & Big Cypress)).

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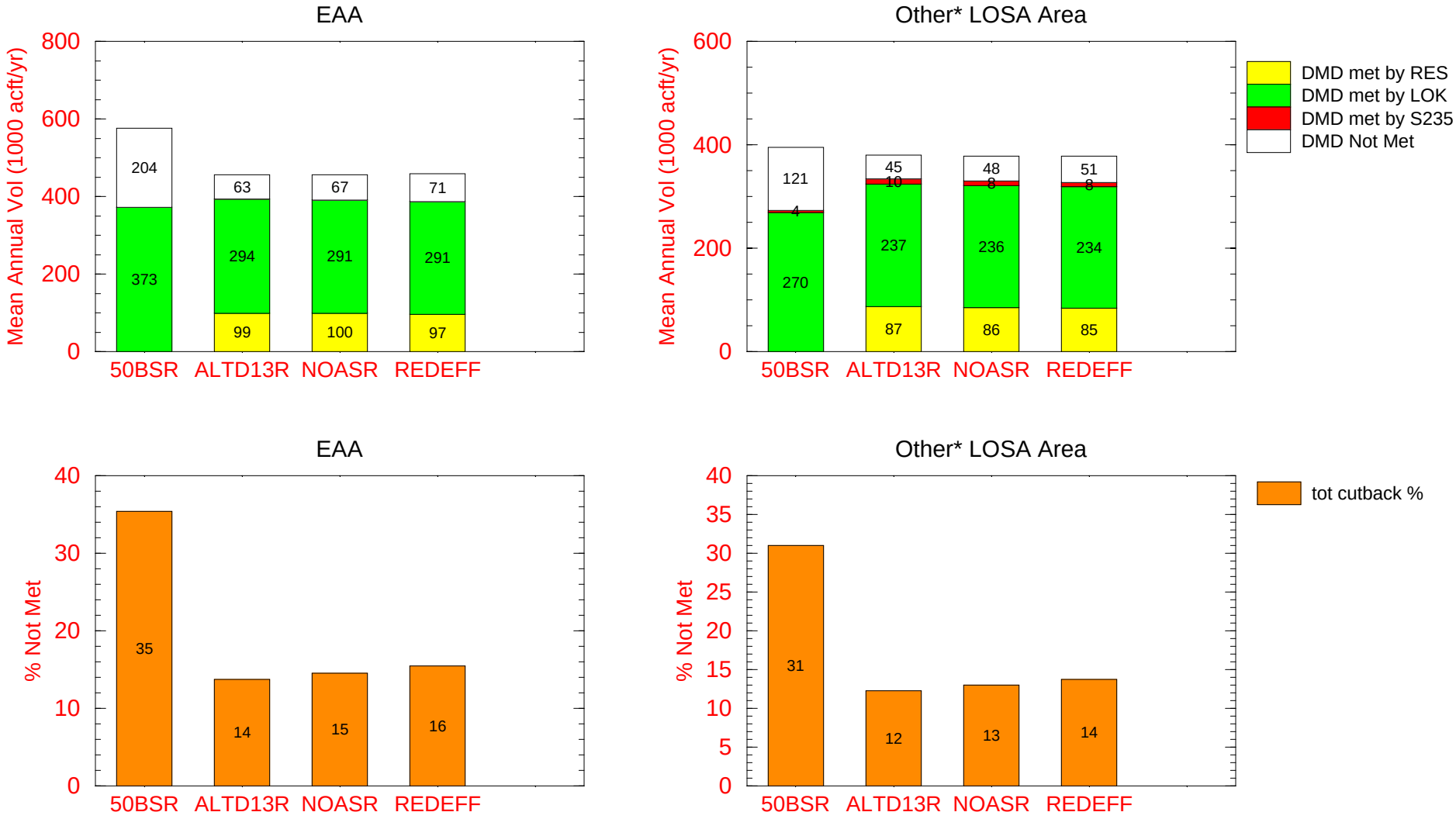
Figure 2. Mean Annual EAA/LOSA Supplemental Irrigation: Demands and Demands Not Met for the Drought Years: 1971, 1975, 1981, 1985, 1989 within the 1965 − 1995 Simulation Period



*Other Lake Service SubAreas (S236, S4, L8, C43, C44, and Seminole Indians (Brighton & Big Cypress)).

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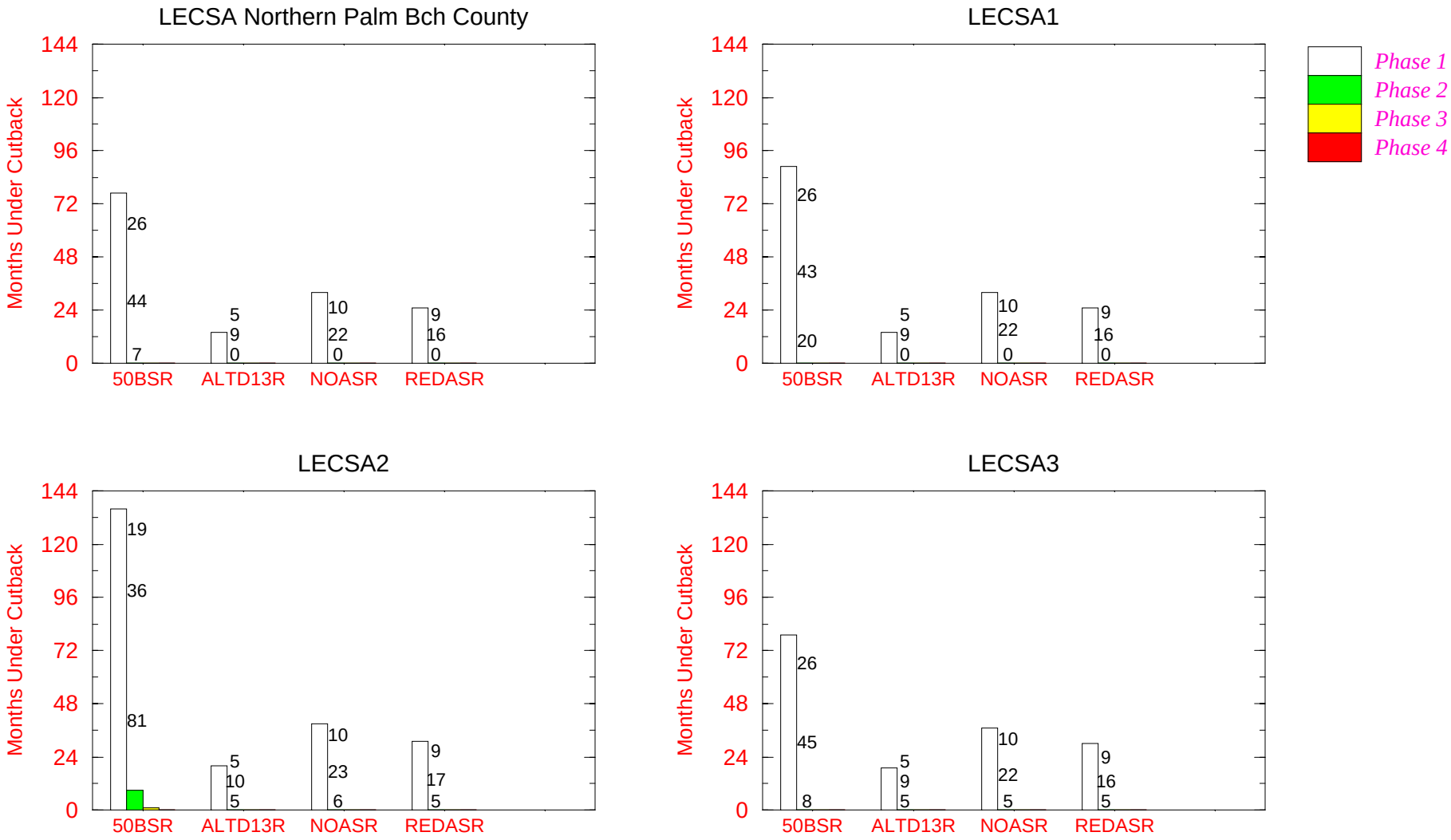
Figure 3. Number of Months of Simulated Water Supply Cutbacks for the 1965 − 1995 Simulation Period



Note: Phase 1 water restrictions could be induced by a) Lake stage in Supply Side Management Zone (indicated by upper data label), b) Local Trigger well stages (lower data label), and c) Dry season criteria (indicated by middle data label).

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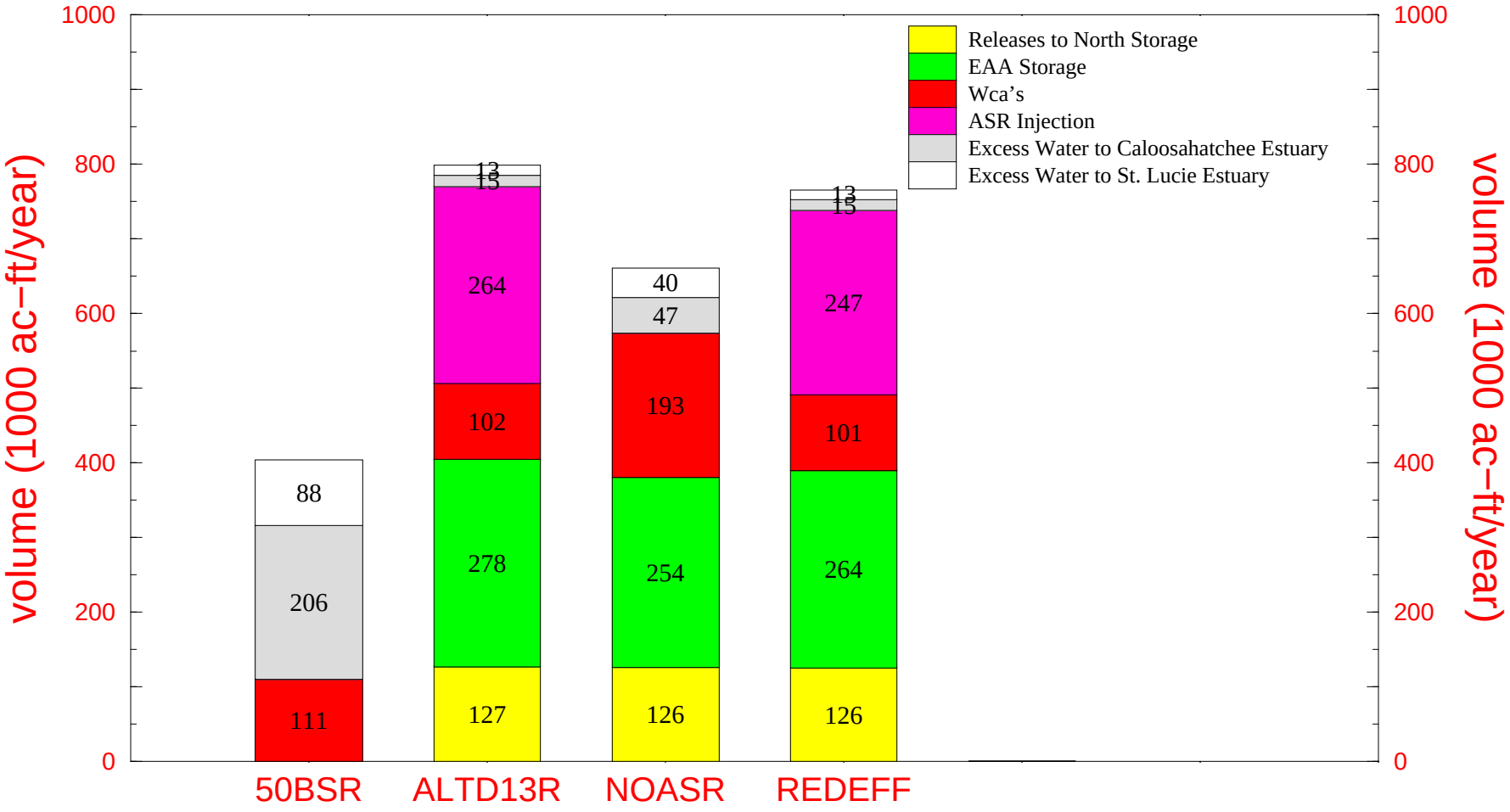
Figure 4. Mean Annual Flood Control Releases from Lake Okeechobee for the 31 yr (1965 − 1995) Simulation



Note: Although regulatory (flood control) discharges are summarized here in mean annual values, they do not occur every year. Typically they occur in 2−4 consecutive years and may not occur for up to 7 consecutive years.

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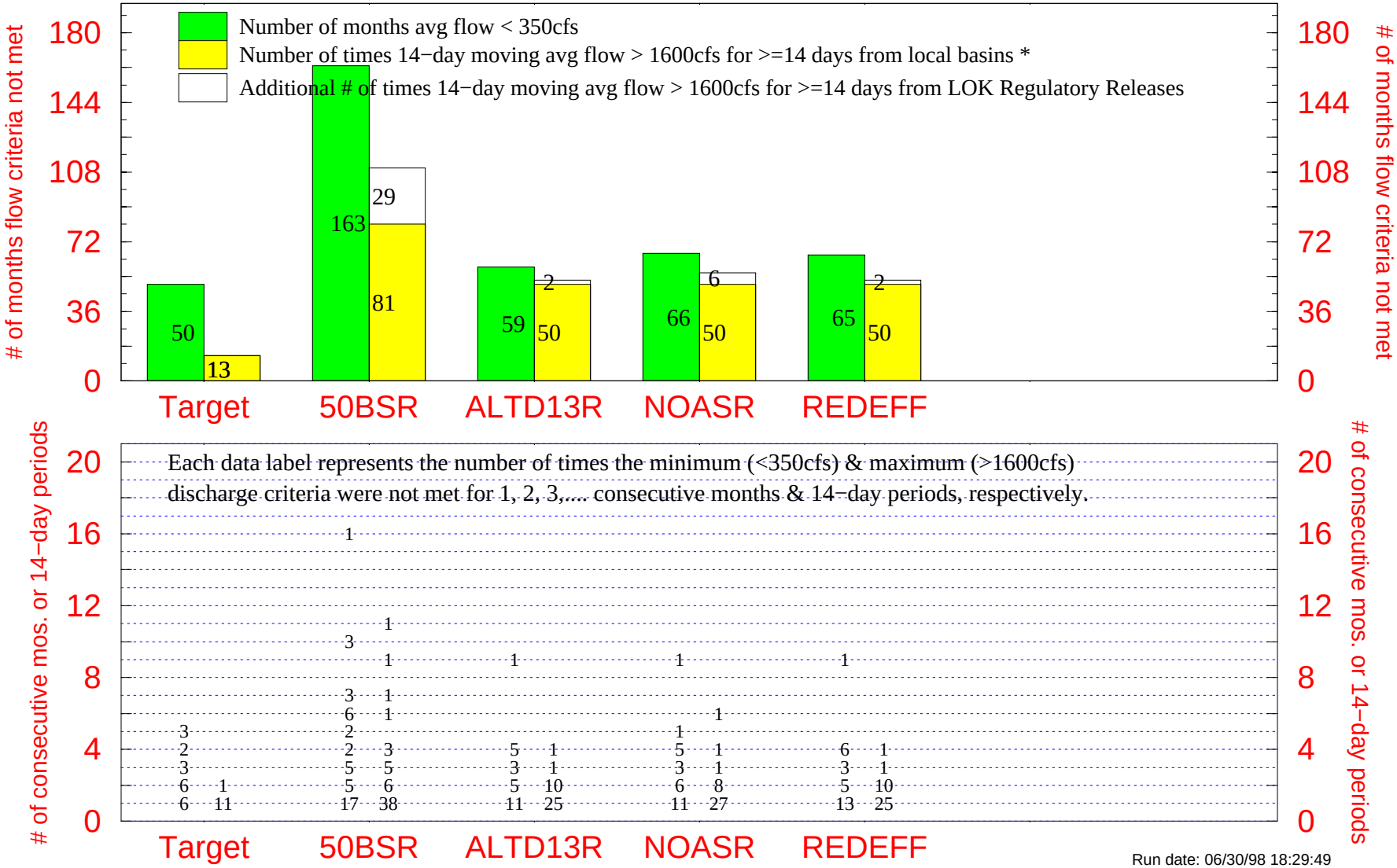
Figure 5A. Number of times Salinity Envelope Criteria were NOT met for the St. Lucie Estuary



Note: local basins include the C−44, C−23, C−24, North Fork, and South Fork Basins

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Figure 5B. Number of times Salinity Envelope Criteria were NOT met for the Calooshatchee Estuary (mean monthly flows 1965 − 1995)

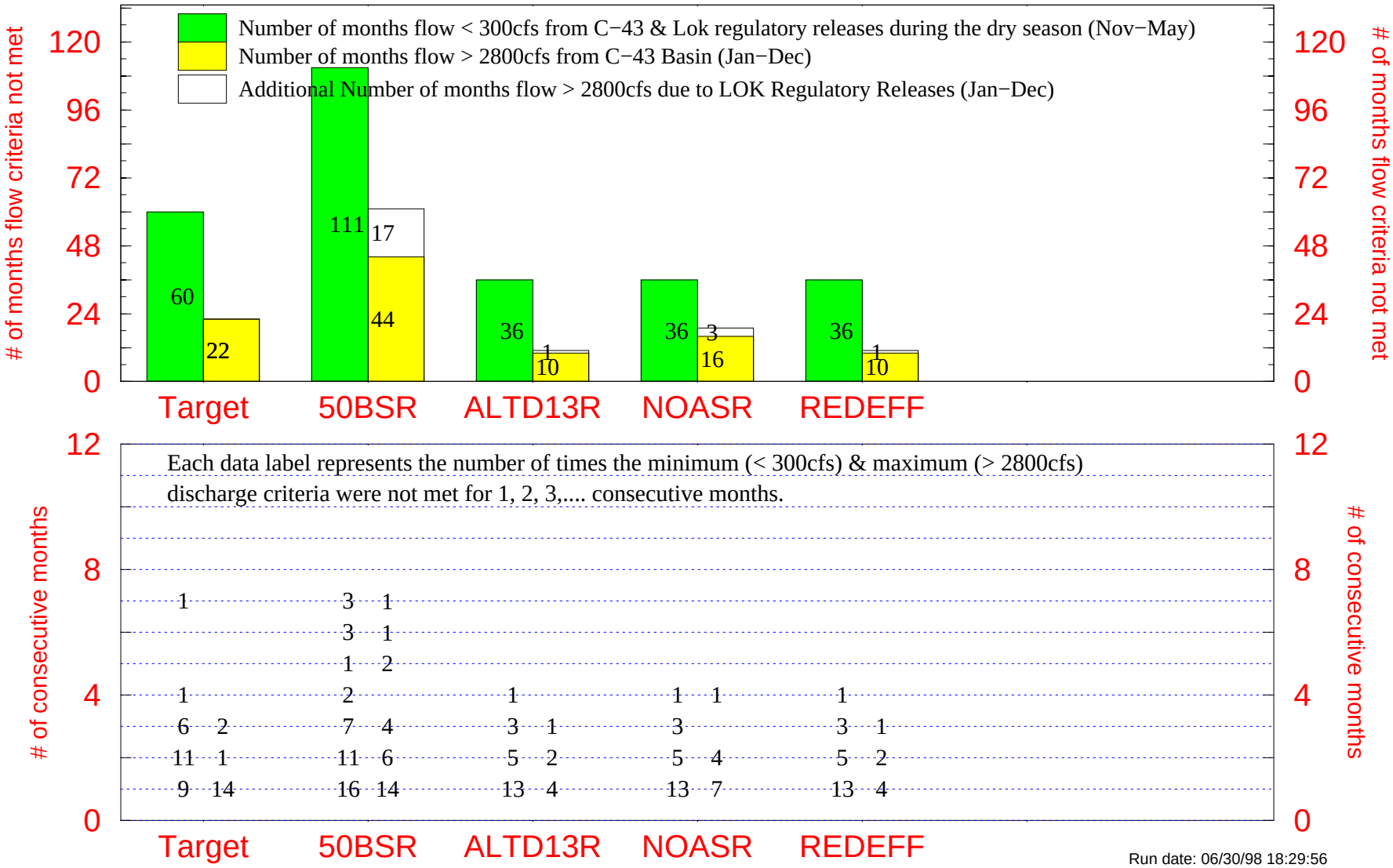

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Figure 6. Number of Undesireable Lake Okeechobee Stage Events

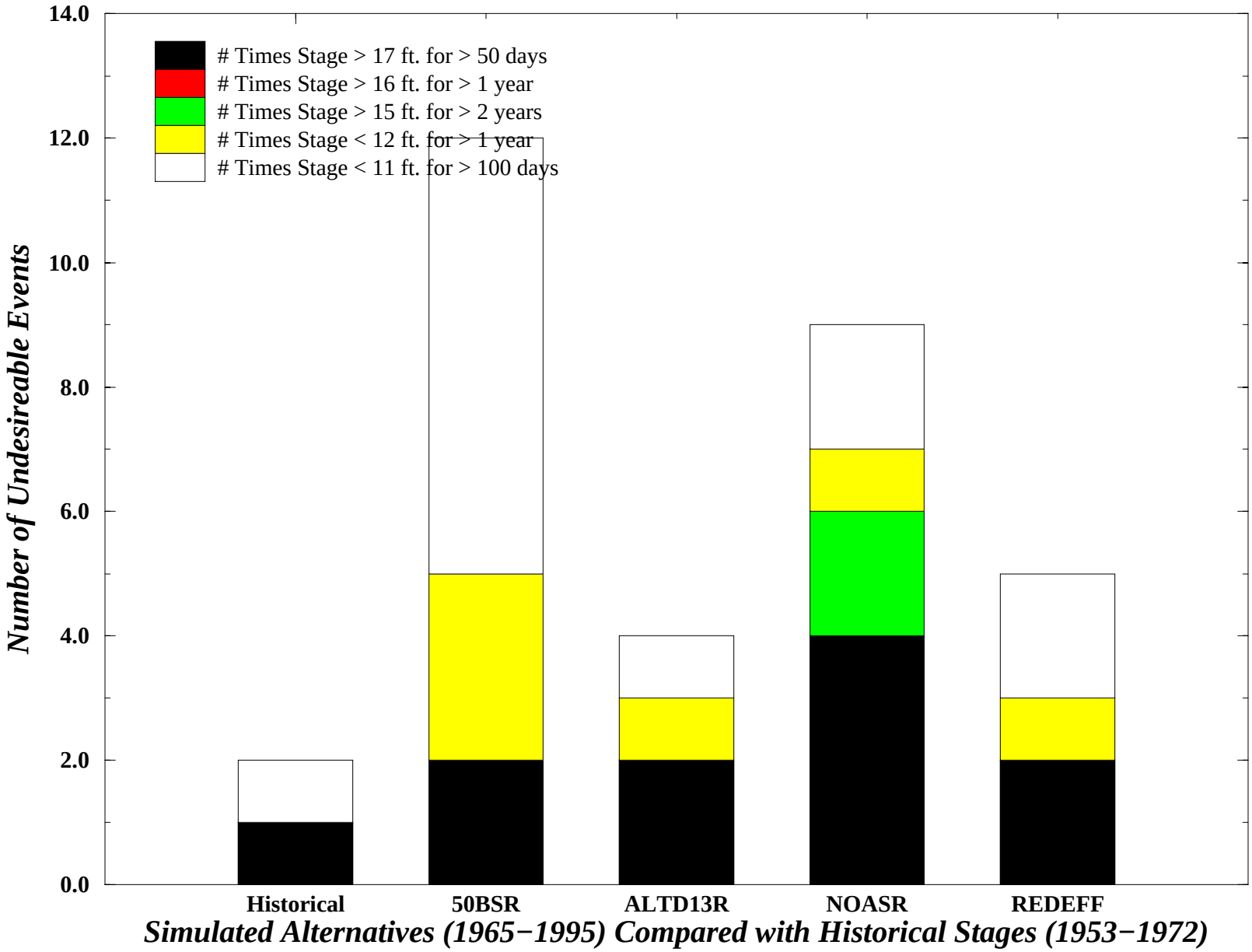

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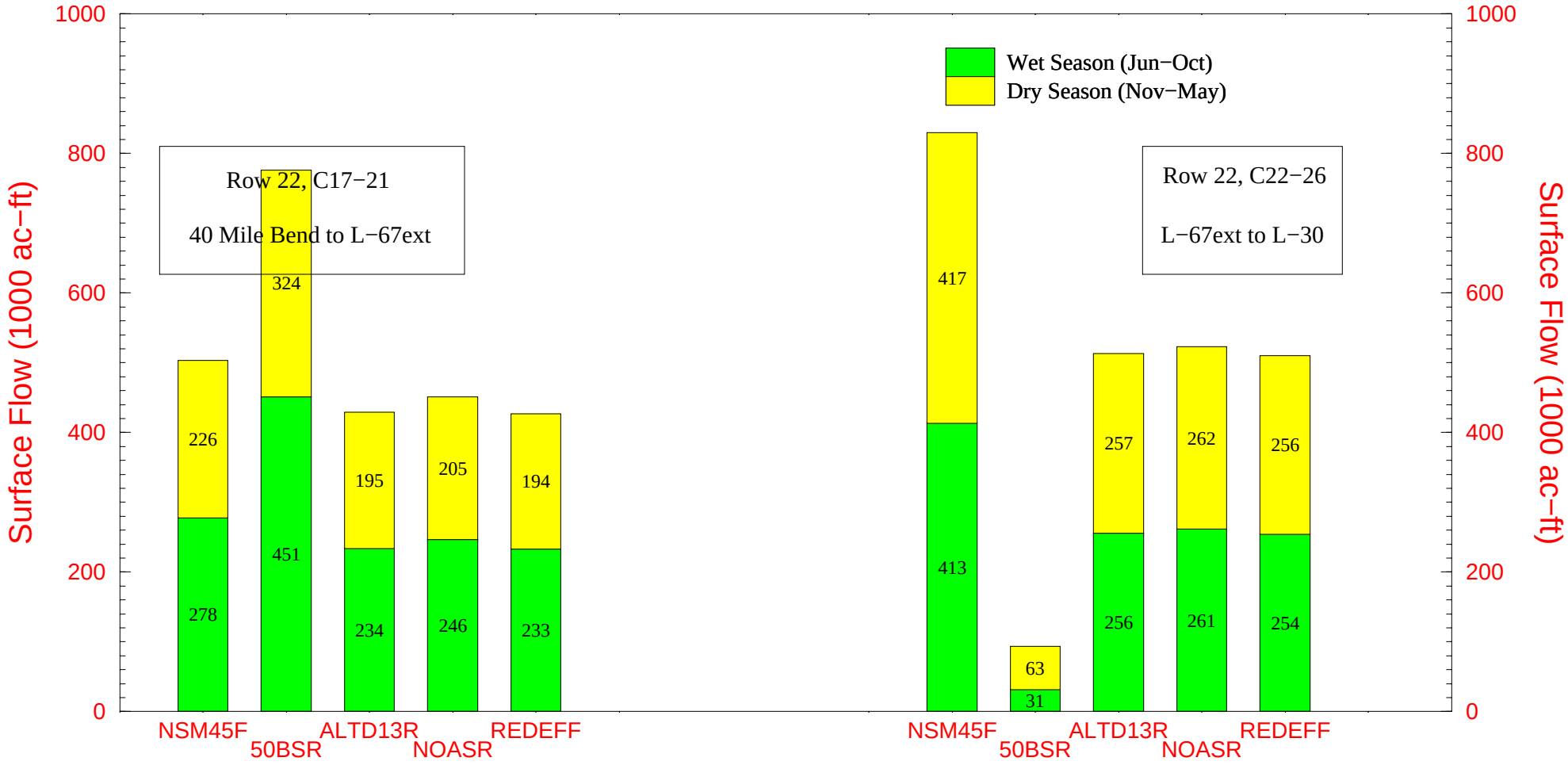
Figure 7. Average Annual Overland Flows to ENP South of Tamiami Trail, West & East of L−67ext for the 31 year simulation period



Note: Flow represents overland flows for cells Row 22 Columns 22 thru 26. NSM water depths at key ENP gage locations are used as operational targets for most alternatives. NSM flows are NOT targets and are shown for comparative purposes only.

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